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Nutrients, nutrition, nourishment

See and enjoy food whole

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Access 2010 Nutrition Resarch Reviews Anthony Fardet on whole grains here
Access December 2012 The Food System position paper here
Access January 2014 Gyorgy Scrinis on nutritionism and margarine here
Access February 2014 The Food System position paper on reformulation here
Access June 2014 Advances in Nutrition Anthony Fardet et al on holism here
Access 2014 Journal of Cereal Science Anthony Fardet on cereal products here
Access 2014 Cereal Foods World Anthony Fardet on reductionism and holism here
Access November 2014 Brazilian national dietary guidelines here

Editor's note

This ground-breaking commentary Is by *WN* editorial family member French food scientist Anthony Fardet. He outlines why the isolation of some specific nutrients and other bioactive compounds in whole foods, in the belief that these and not the foods themselves are the key to good health and protection against disease, is wrong. Following the work of Gyorgy Scrinis and Michael Pollan on 'nutritionism', he distinguishes between a reductionist and holistic paradigm. He foresees the future of nutrition as nourishment from food as a whole, and not from some of its isolated chemical constituents. The example he gives is wheat, and cereal products of which some parts of the whole wheat berry are ingredients.

The *World Nutrition Food System* series beginning in 2010 specifies a whole new thesis on nutrition and health. This sets aside the 'classic' food groupings that have been used for almost a century. Instead it classifies foods in terms of the nature, extent and purpose of their processing (1). All foods are classified as unprocessed or minimally processed, or as processed culinary ingredients, or as processed food products, or as ultra-processed food products. Specifically (1):

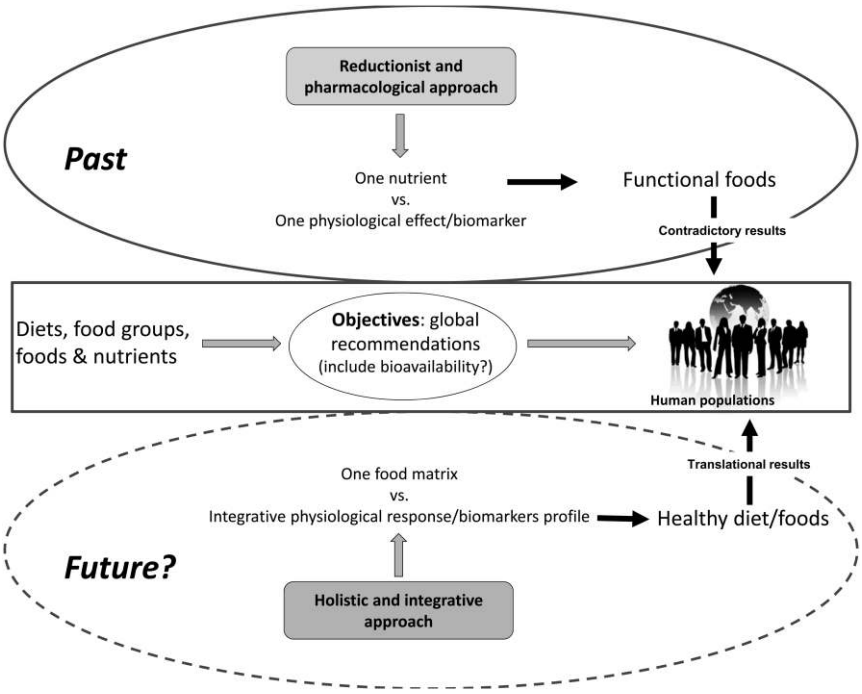
> Ultra-processed products are not made from foods. They are made from ingredients. Some of these are derived from foods, such as oils, fats, flours, starches, and sugar, but many are obtained by the further processing of food constituents, such as hydrogenated oils, hydrolysed proteins, starch-modified sugars, and extruded or otherwise processed remnants of meat. Numerically, the great majority of the ingredients of ultra-processed products are additives of a variety of types…. The function of many of these is to make the product look, smell, feel and taste like food. Bulk may come from air or water. Synthetic micronutrients may be added to 'fortify' the products.

Compared with dishes and meals made from minimally processed foods and culinary ingredients, ultra-processed 'fast food' and snack products are denser in calories, poor in nutrients, and less satisfying (2,3). They are now more and more consumed worldwide. Their sales are rising most rapidly in middle- and low-income countries.

Another characteristic of ultra-processed products is that they have none of the structure of minimally processed foods, and so have lost any natural balance of nutrients and other bioactive compounds. Justification for these products is not only commercial. It also follows the reductionist paradigm of much of modern Western science (4). This commentary shows how a shift toward a philosophy of food science and human nutrition based on a renewed holistic paradigm will enable preservation of the healthful qualities of foods. The example given is cereals (grains) and wheat in particular, and cereal products.

The fallacy of reductionism

Figure 1
From nutritionism to nourishment



The ellipse on top of this diagram represents the current convention of reducing foods to some of their constituent parts, a quasi-pharmaceutical type of reductionism known in this field as nutritionism. The ellipse below shows the approach that is now gaining force, of realising that the qualities that protect health and well-being come from the structure and contents of foods as a whole.

Reductionism is the ideology that advocates reduction of complex phenomena to their simplest components. These are assumed to be more significant than the phenomena as a whole. But reality is complex. Reductionism is a defining characteristic of modern conventional food science and human nutrition (4). Known in this field as nutritionism – the reduction of food to some of its chemical constituents – it fractionates natural foods into some of their ingredients or nutrients. Ultra-processed food products, functional foods and micronutrient supplements are all examples of the practice of reductionism applied to the whole food matrix. But

fractionation of natural foods and then recombination of some of their ingredients into ultra-processed products, ignores the significance of food structure and nutrient interaction in human health.

This approach is in effect pharmacological. It treats elements of foods identified as healthy as if they are drugs, associating one bioactive compound with one physiological effect, as indicated in Figure 1 above. But reality is far more complex! Splitting phenomena into isolated entities can cause disconnection from complex reality. Food compounds are not drugs, and preventive nutrition is not pharmacology (5,6). Experimental designs for nutrition intervention studies meant to gain insights into improved health use pharmacological models! Why? This is because conventional nutrition science assumes that the right way to identify and correct unbalanced human diet is to think of elements of food in effect as the drugs used to prevent and treat diseases.

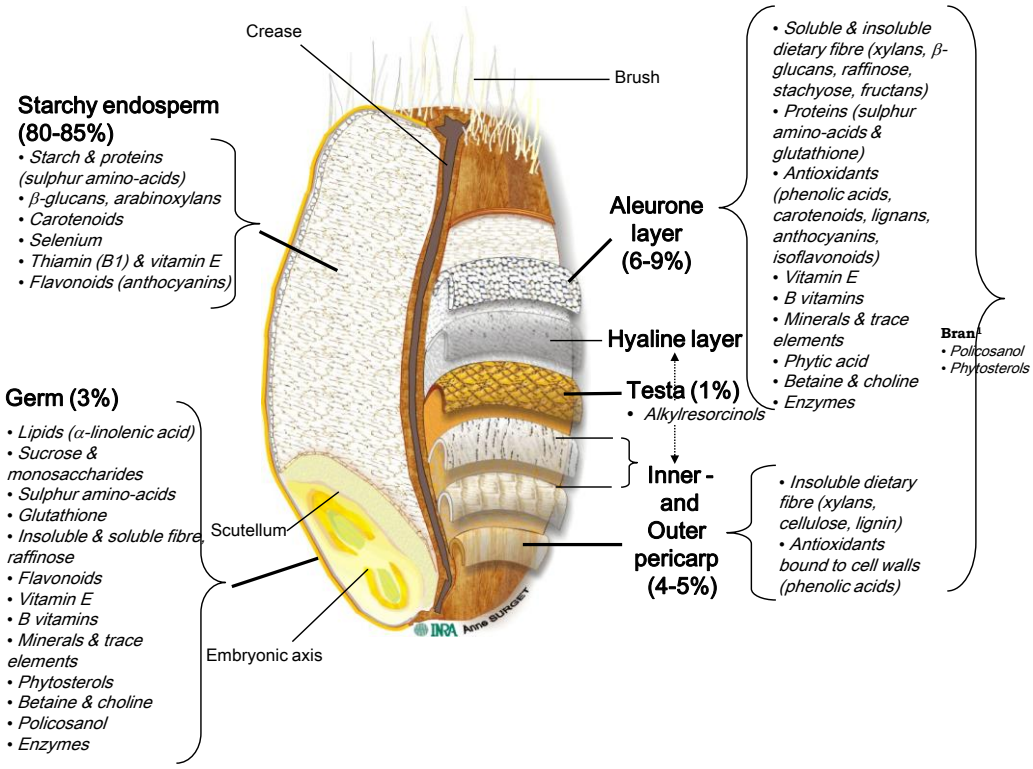
It is therefore no surprise that intervention studies using isolated compounds added to a test population of subjects, often using pharmacological doses far higher than ever could be found in food, give disappointing results, and even evidently increase risk of disease (as shown with carotenoids and vitamin E) (4). The compound may well be protective within its naturally evolved matrix in whole food, acting in synergy with other compounds, and also other foods. When complexity is ignored, in other words reality is ignored, the chance of a good result is coincidental or minimal. By analogy, this approach is like identifying one ideal soccer player as the best building a team with ten more players with practically identical qualities. This can only lead to failure. Players succeed by interaction with other players with distinct and different qualities. Success requires synergy, and not using the 'superstar' in 'super doses'!

The example I now give, is grains (cereals) and their products. These illustrate reductionism pushed to its extreme limits. Figure 2 below is a diagram of a whole wheat berry, showing its constituent parts and a substantial number of its nutrients and bioactive compounds. Most wheat is milled and refined to make white wheat flour. The most nutrient-dense fractions are removed, and the germ and bran are often sold separately as 'health food' or animal feed. White wheat flour has lost most of the bioactive compounds in the wheat berry. Recognising this fact, food scientists have found ways to re-incorporate germ and bran into white flour, and other constituents such as aleurone fractions. This all has an environmental cost because of the energy used in refining and recombination (7). Ironically, food manufacturers then make health claims for what at best is a very partial approximation to a milled version of genuine whole wheat grain.

Whole foods are the most healthy

Figure 2

Whole wheat is more than the sum of its parts



Foods are most healthy when they are consumed in whole form. This diagram of a whole wheat berry helps to explain why. When processed only some of the bioactive compounds shown here are used, and their natural balance with one another is lost. Also the act of milling wheat into flour destroys the structure of the whole food, which is also part of its healthy quality

This explains why the reformulation of ultra-processed products will not improve public health (8). Why? This is because reformulation can only be a partial attempt to improve products that are inherently unhealthy. It will also mislead customers into thinking that the product is positively good for their health. The epidemics of obesity and of diabetes will only continue to grow.

By contrast with reductionism, the philosophy of holism is that naturally interconnected systems, whether these are for example physical, biological, chemical,

social, economic, mental, or linguistic, need to be seen as wholes (4). Their functioning cannot be fully understood solely in terms of their component parts (9). A principle of holism is that the whole is always more than the sum of the parts.

It follows that the integrity of whole foods should be respected, and that processing should usually be only minimal (1). Foods like grain which are not eaten raw are best processed in ways that keep them close to their original state. The role of processing is to improve their nutritional quality, not to degrade it, and also to take into account social, cultural, economic and environmental factors (3,7). Pre-fermentation, pre-germination or soaking of cereals is well known to improve their nutritional density while preserving their food structure, and can increase the amount of bioavailable vitamins, minerals and phenolic acids (10).

A holistic view of foods takes into account the synergetic effect of the nutrients contained in them. Whole wheat grain contains more than 30 potential antioxidant compounds (9). All have different antioxidant effects, either trapping free radicals, regenerating another antioxidant that becomes pro-oxidative after having exerting its antioxidant effect, or acting as co-factors of antioxidant enzymes within the human organism (11). They have the same effect with different mechanisms of action. The concept of synergy is itself holistic in nature. The physiological effect of the whole package of compounds is more than the sum of the effect of each compound taken separately (4). This is likely to be true also for hypolipidemic, anticarcinogenic, and anti-inflammatory and other properties and effects (5).

One important example of the need to respect the natural food matrix is the new well-accepted concept of dietary fibre co-passenger (12-14). To quote an authority on this topic, 'About 95% of grain phenolic compounds are linked to cell wall polysaccharides…[These] phenolic compounds are covalently bound to polysaccharides through ester bonds' (14). They are progressively released within the digestive tract up to the colon.

By being bound to dietary fibre, phenolic compounds are protected from digestive processes and so are able to reach the colon where they can have their full antioxidant good effects on the free radicals produced by those species of microbiota that can damage colonic cells, and potentially lead on to colon cancer. That is to say, the benefit is from the phenolic compound and the dietary fibre working together. Isolated dietary fibre, or substances added to cereal products that have the same chemical composition as dietary fibre, will not have this protective effect.

As evident from Figure 2, grains (cereals) have a complex structure. The reductionist paradigm assumes that this structure has no significance. The holistic paradigm asserts that structure, and the relationship of the constituent elements within this structure, is vital, and that the preservation of food structure is essential for the full health potential of foods. Evidence supports the holistic paradigm. Here are three reasons why. There are others.

Bioavailability

Food structure influences the kinetics of release of bioactive compounds whose nutritional effect differs (15). For example, pasta and bread made from durum wheat with identical chemical compositions show different glycaemic indices, pasta being characterised as a source of slow-release carbohydrates and bread of rapid-release carbohydrate (16). The same is true when comparing bread containing intact wheat kernels as distinct from milled flour (17), or muesli-type breakfast cereals in contrast to extruded breakfast cereals (18). Many other such examples can be given. The concept of slow-release versus rapid-release carbohydrate can be extrapolated to all nutrients, because the kinetics of release affects health (15). In my own investigations I have identified rapid versus slow phenolic acids in cereal products. Rapid phenolics (around 5%) are rapidly released in upper digestive tract. Slow phenolics (around 95%), being bound to dietary fibre, are progressively released. These are the type that protects the colonic mucosa.

Satiety

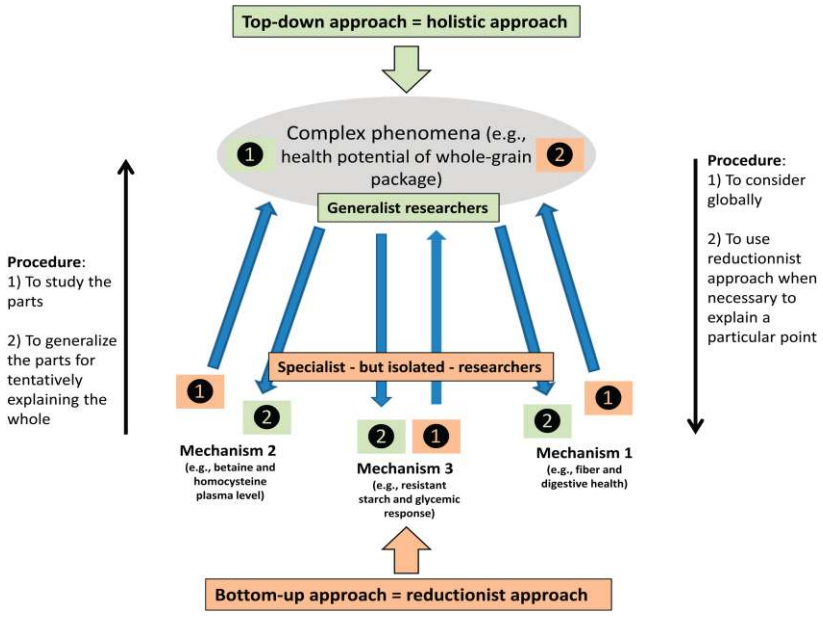
Food structure effects satiety. The more the food matrix is preserved, the more satisfying, demonstrated in a classic experiment contrasting intact apples, apple purée and apple juice(19). In whole or minimally processed form, vegetables, legumes (pulses), nuts and seeds are all satisfying, and meals, dishes and foods mainly made from minimally processed foods are satisfying and so prevent hunger and help to avoid snacking between meals.

Synergy

In general, the holistic paradigm, with its central concept of interaction and synergy between the constituents of natural and minimally processed foods, clearly implies amplification of the benefits of foods as a whole as protection against oxidation, inflammation, cardiovascular diseases and cancer. Work on this concept continues to progress (9).

Revolutionising research

Figure 3
From reductionism to holism



The current conventional approach to research into food, nutrition and health, being reductionist, begins with isolated elements in food, as shown in the bottom half of this figure, and extracts data. By contrast, the holistic approach starts with foods in whole form, as shown in the top half of the figure, and thus begins with an idea which is then tested against information from aspects of the food

What is now the conventional model for research into food, nutrition and health needs to be turned on its head, as shown in Figure 3, above. The holistic approach begins with a general view, using reductionist methods to investigate specific points. But dominant research works in the opposite direction, generalising from results on isolated components. Hence belief in the special value of micronutrient and other supplements and functional foods, and the rationale for ultra-processed products.

Reality is complex. It is more logical first to address a complex issue using a holistic approach. Grains (cereals) and cereal products, my own speciality, is just one important example, which alone has huge implications for producers, manufacturers and consumers. Holism can be translated in the form of questions meant to be answered by research. Some examples follow.

- What do prospective cohort studies on associations of 'consumption of whole/refined grains-health' or 'consumption of diets rich in whole-grain cereals-health' show? Little work has so far been done on such questions.
- What do intervention studies comparing different diets based on whole as opposed to refined grain products show? Do they confirm observational studies? The impact of food structure should be studied more.
- If yes:
  - How do whole as opposed to refined grains act on metabolism as a whole (the metabolome) and gene expression (transcriptome)?
  - What are the characteristics of grain products that may explain their health effects? These may include physical structure or synergism of several compounds.
  - Do cereal products need to be part of a more complex system fully to express their health effects?

Depending on findings in response to questions like these, it may be then be useful, based on the results of interventions that have identified activated or repressed metabolic pathways or genes, to use a reductionist approach. This could focus on finer points, such as the digestive fate of for example whole grains, or anti-nutrients, or the role of for example betaine and choline as contained in whole grains.

Conclusion

The health potential of whole-grain cereals cannot be reduced to one or two physiological effects associated with only a few grains and few phytonutrients. Working from the particular to the general will not produce satisfactory and sustainable results. Reductionism has reduced the health potential of grains (cereals) and cereal products to their dietary fibre fraction or to their relative glycemic indices. This has led to massively funded work on genetic manipulation to increase apparent benefits in these areas, which among other harmful effects reduces biodiversity (3).

It is now commonly felt inside and outside the profession that nutrition science is in a *cul de sac* – a blind alley. Recent and current disputes about which nutrients are most relevant to states of health and risk of disease suggest confusion. Dietary guidelines issued by UN agencies and governments whose recommendations are largely nutrient-based seem not to have a significant effect on rates of obesity and diabetes, which are now rapidly increasing. Findings which now seem to be important and conclusive, including those on sugared soft drinks, on *trans*-fatty acids, on salt, and

indeed on mass-manufactured white breads and sugared breakfast cereals, are surely best seen as being not actually about nutrients. They are about the nature, purpose and intensity of food processing and the impact especially of aggressive types of processing on the ingredients of ultra-processed food and drink products.

As has been stated elsewhere (1,3,8), an emphatic distinction between minimally processed foods made into freshly prepared meals, and packaged energy-dense fatty, sugary or salty snack and other 'convenience' products, seems more likely to lead to findings, policies and actions that will protect and improve public health. In such initiatives, the vital importance of the matrix, structure and synergism of the components of foods in whole or minimally processed form, by themselves and also in combination, needs to be recognised, investigated, and emphasised.

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Status

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